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KOTA WHEAT.¹

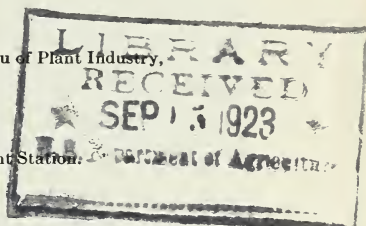
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WHAT IS KOTA WHEAT?

The variety of wheat called Kota (a part of the State name North Dakota) is a common wheat of the hard red spring class.

HISTORY.

In 1903 Prof. H. L. Bolley, of the North Dakota Agricultural Experiment Station, made a study of the flax industry of Europe for the United States Department of Agriculture. In a collection of seeds brought from Russia by Professor Bolley at that time were 25 lots of wheat. These 25 lots were given S. P. I. numbers 10194 to 10218.² No individual record of these numbers was published, the printed statement being simply "10194 to 10218.³ *Triticum vulgare*. Wheat." The unpublished records of the Office of Foreign Seed and Plant Introduction show that Professor Bolley furnished data as to the locality from which each lot of wheat was collected and usually specified whether it was a spring or winter wheat. No samples of these importations are now on file in the office mentioned, and

¹ The manuscript of this circular was submitted for publication April 19, 1923.

² Seeds and plants imported during the period from December, 1903, to December, 1905. Inventory No. 11; Nos. 9897 to 16796. U. S. Dept. Agr., Bur. Plant Indus. Bul. No. 97, p. 7. 1907.

³ Accession numbers of the Office of Foreign Seed and Plant Introduction.

evidently no portion of the original lots was delivered to that office by Professor Bolley, as the record cards are stamped "No samples."

During the years immediately following the introduction of these wheats, Professor Bolley grew at least part of them at the North Dakota Agricultural Experiment Station, near Fargo, N. Dak. Among them was one which he designated "BR3," and identified later as selected from S. P. I. No. 10214.⁴ The unpublished records of this introduction show it to be a "winter wheat from Belachov, Tambof Government." As BR3 is a spring wheat it is evident that the identification of the original material was incorrect or that the winter wheat contained a mixture of spring wheat, which is now all that survives of the original importation. In 1911 Professor Bolley distributed his BR3 wheat to several farmers. Those who received it apparently did not continue to grow it, as it did not become commercially established from that distribution. No further distribution appears to have been made by Professor Bolley for several years following 1911.

Several lots of durum wheat were included in the 25 samples imported by Professor Bolley. Of four of these durum wheats 10 pounds each were sent to the Dickinson substation in 1911.⁵ At that time Mr. Waldron was superintendent of the Dickinson substation and Mr. Clark was in charge of the cereal experiments conducted there in cooperation with the Bureau of Plant Industry. One of the durum wheats sent to Dickinson was designated by Professor Bolley as D-1 (Durum No. 1) and later named Monad. In this lot there was an admixture of common wheat. The common wheat in the mixture was noted by the writers when both were located at Dickinson, but the mixture was not separated at that time. In the severe rust epidemic of 1916 D-1 (Monad) durum wheat proved to be distinctly resistant to black stem rust. In examining threshed wheat of D-1 grown at Dickinson in 1916 Mr. Clark noted the plumpness of the common wheat mixed with it and suspected that it was rust resistant. In a study of nursery-row samples of D-1 at Fargo in 1917 Mr. Waldron noted the rust resistance of the common-wheat mixture. At that time Mr. Waldron was plant breeder at the North Dakota Agricultural Experiment Station and Mr. Clark was assistant in western wheat investigations in the Office of Cereal Investigations. Each of them made selections from the mixture in 1917, and in 1918 these selections were studied to determine their rust resistance. At the State agricultural experiment stations in North Dakota, South Dakota, and Minnesota they proved to be resistant to black stem rust.

Previous to this time resistance to stem rust of wheat was a quality not known to be reported upon in any variety of hard red spring wheat grown in the United States, although long recognized in several varieties of durum wheat. The discovery of resistance to stem rust in a spring common or bread wheat, therefore, was important.

A comparison of the common wheat found as an admixture with D-1 (Monad) with a wheat grown on the trial plats of Professor

⁴ Letter from Prof. H. L. Bolley, dated Apr. 18, 1919, in the files of the Office of Cereal Investigations.

⁵ Correspondence between Professor Bolley and the Dickinson Substation, in 1911, indicates his intention to send seed of 4 durum varieties of BR3, but the records of the substation show that only the durums were received, accessioned, and grown.

Bolley at Fargo was made by the writers in 1918, and the two were found to be very similar, if not identical, in morphological characters. It was found that the latter wheat was designated by Professor Bolley as RBR3. The existence of this wheat as an unmixed variety was unknown to the writers until the growing season of 1918. The experiments conducted in 1918 not only showed the rust resistance of the wheat (then designated as C. I. No. 5878) found as an admixture in D-1, but they indicated that it would yield well and that it had good milling and bread-making qualities. The results of these experiments were presented and the name Kota was applied to the variety in an article published in the Journal of the American Society of Agronomy in 1919.⁶

In the spring of 1919 Professor Bolley made a distribution of his RBR3 wheat, sending 2 bushels of seed to Jalmer Herre at Kelso, N. Dak. The increase made by Mr. Herre was one of the earliest and was the most important. Two lots of wheat, similar in all respects, were thus established, one selected by Mr. Waldron and increased by the North Dakota Agricultural Experiment Station and the other distributed by Professor Bolley and commercially grown and distributed by Mr. Herre.

DESCRIPTION.

Kota is a hard red spring common wheat. It is bearded and has glabrous white chaff or glumes. The beaks (short beards on the outer chaff) of Kota vary from one-eighth of an inch to 1 inch or more in length. (Fig. 1.) This character makes the variety easily distinguishable from Preston (Velvet Chaff), which has beaks varying only from one-sixteenth to three-sixteenths of an inch in length. In appearance of both heads and kernels, Kota closely resembles the hard red winter varieties, Turkey, Kharkof, and Kanred. The kernels of Kota are hard, rather long, dull red, and have a small germ similar to that in varieties of hard red winter wheat. The stems of Kota are rather weak, and in humid sections or on very rich, heavy soil the variety is likely to lodge. Kota heads and matures slightly later than Marquis, so its greater freedom from rust injury is not due to greater ability to escape this disease by maturing earlier.

The leaves of Kota wheat sometimes dry and shrivel shortly after the plants are headed. This is especially likely to occur if they are infected with leaf rust (*Puccinia triticina*), to which the variety is quite susceptible. This rust usually does very little damage to the crop, although in a few instances it apparently has caused injury. In 1921 extreme summer temperatures occurred which Kota did not withstand as well as some other varieties. This was not the usual drought, as in most sections where the variety was grown there was sufficient moisture in the soil to carry the crop past the critical period. When soil moisture has been the limiting factor, Kota usually withstands the extreme conditions better than other hard red spring wheats. Evidence of this may be found in a study of Table 4.

Since 1918 a considerable mass of experimental data has been recorded on the resistance of Kota wheat to stem rust, on its yield, and on its milling and baking value. The important question is the

⁶ Waldron, L. R., and Clark, J. A. Kota, a rust-resisting variety of common spring wheat. *In Jour. Amer. Soc. Agron.*, v. 11, no. 5, p. 187-195. 1919.



FIG. 1.—A spike, glumes, and kernels of Kota wheat. Spike and glumes natural size; kernels in three positions and in transverse section, magnified 3 diameters.

value of Kota when compared with Marquis, the leading variety of hard red spring wheat.

RESISTANCE TO STEM RUST.

That Kota wheat is resistant in the field to the forms of stem rust (*Puccinia graminis tritici*) that predominate in the spring-wheat area is definitely shown by experiments in each of the four years since 1918, when its resistance was first determined. This disease has caused enormous damage to susceptible spring wheats in each of these years.

During the four years from 1919 to 1922, uniform rust nurseries containing all the important varieties of spring wheat have been grown at many agricultural experiment stations in the spring-wheat region. Percentages of infection of stem rust in these nurseries have been recorded and further rust notes have been made on some of the field plats where the varieties were grown for yield comparisons. From many of the plat experiments, however, rust notes are not available.

The percentages of stem-rust infection which have been recorded on Kota and Marquis wheats in the nursery-row experiments are shown in Table 1. The average for each station is shown where the varieties have been grown two years or more. Averages for all observations for each year and for all years are shown at the bottom of the table.

TABLE 1.—Annual and average percentages of stem-rust infection recorded on Kota and Marquis wheats grown in nurseries at 23 agricultural experiment stations in the Central States during one or more of the four years from 1919 to 1922, inclusive.

[T=trace.]

Station.	Percentage of stem-rust infection.									
	1919		1920		1921		1922		Average for years both were grown.	
	Kota.	Marquis.	Kota.	Marquis.	Kota.	Marquis.	Kota.	Marquis.	Kota.	Marquis.
Fargo, N. Dak.....	10	100	10	65	5	90	35	98	15	88
Langdon, N. Dak.....					1	25	T	40	1	33
Edgeley, N. Dak.....					T	85	T	45	T	65
Mandan, N. Dak.....	T	25	T	65	0	8	15	40	4	35
Dickinson, N. Dak.....	(1)	(1)	1	16	T	5	20	55	7	25
Newell, S. Dak.....	5	50								
Highmore, S. Dak.....	T	70	5	25					3	48
Redfield, S. Dak.....							3	80		
Brookings, S. Dak.....	5	85	40	60	5	50	12	65	16	65
Morris, Minn.....					15	40	15	30	15	35
Crookston, Minn.....					2	90	5	90	4	90
Golden Valley, Minn.....					0	10				
Duluth, Minn.....					T	55	14	75	7	65
St. Paul, Minn.....	0	40	33	98	T	40	T	50	8	57
Waseca, Minn.....							8	95		
Madison, Wis.....					T	85	5	4	3	45
Chatham, Mich.....							0	45		
Ames, Iowa.....					5	28	T	35	3	32
Lincoln, Nebr.....	4	75	4	23	(2)	(2)	5	30	4	43
Manhattan, Kans.....	T	70								
Cheyenne, Wyo.....	10	65	25	40	0	5	1	0	9	28
Akron, Colo.....	T	13	15	50	(1)	(1)	7	T	7	21
Amarillo, Tex.....	1	65								
Average.....	3	60	15	49	2	44	8	49	7	50

¹ No rust occurred.

² Rust notes not recorded.

In 1919, rust notes were obtained at 11 stations. The percentage of rust on Kota wheat varied from a trace at several points to 10 per cent at Fargo, N. Dak. Infection on Marquis wheat, grown under similar conditions, varied from 13 per cent at Akron, Colo., to 100 per cent at Fargo, N. Dak. The average for the 11 stations shows infection of 3 per cent on Kota and 60 per cent on Marquis.

In 1920, rust notes were obtained at nine stations. Infection on Kota wheat varied from a trace to 40 per cent and on Marquis from 16 to 98 per cent. The average for the nine stations was 15 per cent on Kota and 49 per cent on Marquis.

Observations at 14 points in 1921 showed that Kota wheat did not have over 5 per cent of stem-rust infection in any case, while the infection on Marquis under similar conditions varied from 5 to 90 per cent. The average for the 14 trials was 2 per cent on Kota wheat and 44 per cent on Marquis.

Somewhat similar results were obtained in 1922 at 18 stations, the stem-rust infection on Kota wheat varying from 0 to 35 per cent and that on Marquis from a trace to 98 per cent. The average infection in 18 experiments was 8 per cent on Kota wheat and 49 per cent on Marquis.

TABLE 2.—*Annual and average percentages of stem-rust infection recorded on Kota and Marquis wheats grown in plots at seven experiment stations in North Dakota during the five years from 1918 to 1922, inclusive.*

[T=trace.]

Station.	Percentage of stem-rust infection.											
	1918		1919		1920		1921		1922		Average for years both were grown.	
	Kota.	Marquis.	Kota.	Marquis.	Kota.	Marquis.	Kota.	Marquis.	Kota.	Marquis.	Kota.	Marquis.
Fargo.....	7	25	5	22	5	80	1	45	10	80	5.6	50.4
Edgeley.....					4	77	5	85	22	92	10.3	84.7
Langdon.....							2	86	3	35	2.5	60.5
Mandan.....					1	30	0	T	T	2	.3	10.7
Dickinson.....			0	0	2	15	0	4	T	7	.5	6.5
Williston.....							0	3		T	0	1.5
Hettinger.....									T	67		

During the four years 52 direct comparisons have been possible in these nursery experiments, in which the two varieties have been grown at 23 agricultural experiment stations in 11 States. The average of all these comparable experiments showed 7 per cent of stem-rust infection on Kota wheat and 50 per cent on Marquis.

Estimates of percentages of stem-rust infection also are available for Kota and Marquis wheats for most of the years in which they have been grown in field plots at the experiment stations in North Dakota. These data are presented in Table 2, and the yields from the same plots are shown in Table 4. A direct comparison of rust infection and rust damage is thus made possible. Considerable differences in stem-rust infection occur on the same varieties grown under different conditions even at the same experiment stations, as shown in Tables 1 and 2. The same percentage of infection in

different years may cause different degrees of damage. It will be seen from Tables 2 and 4 that the rust caused large differences in yield in 1920, but in 1921 and 1922 equal or greater infection did not cause as much damage to Marquis. The injury from stem rust depends not only upon the number of pustules but also on their size and on the stage of maturity of the wheat plant when infection occurs.

The distinct superiority of Kota over Marquis wheat from the standpoint of resistance to stem rust is readily apparent from the data in Tables 1 and 2. The general occurrence of rust in the spring-wheat region and especially in North Dakota also is noteworthy.

LOSSES FROM STEM RUST IN NORTH DAKOTA.

Stem rust is the greatest single disease factor limiting the yields of wheat in North Dakota. The annual and total estimated wheat

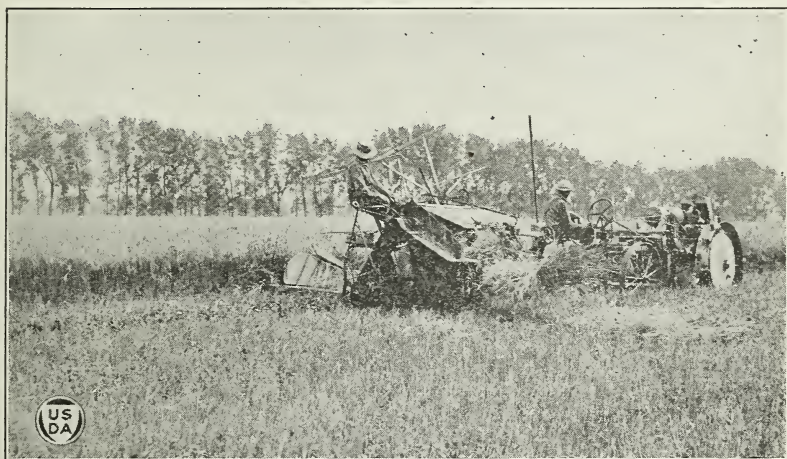


FIG. 2.—Harvesting a field of Kota wheat at the North Dakota Agricultural Experiment Station in 1922.

losses which have occurred in the State during the four years from 1919 to 1922 are shown in Table 3. More than 56,000,000 bushels of wheat have been destroyed by stem rust during the four years, according to the estimates of the Plant-Disease Survey of the Bureau of Plant Industry.

TABLE 3.—Annual and total losses from stem-rust in North Dakota during the four years from 1919 to 1922.

[Estimates made by the Plant-Disease Survey of the Bureau of Plant Industry.]

Year.	Per cent.	Bushels.	Value.
1919.....	20.0	15,318,000	\$36,916,300
1920.....	20.0	18,363,000	23,811,900
1921.....	10.0	9,000,000	7,650,000
1922.....	10.0	13,690,000	12,323,400
Total.....		56,371,000	80,701,600

YIELDS OF KOTA WHEAT.

Kota wheat has been grown in varietal experiments at Fargo, N. Dak., since 1918, and at most of the substations in North Dakota since 1919 or 1920. Since 1921 it has been included in experiments in 12 other States. Table 4 compares the yields of Kota and Marquis wheats grown under the same conditions at 32 agricultural experiment stations and substations in the United States. Fields of Kota wheat at the North Dakota Agricultural Experiment Station, Agricultural College, N. Dak., and at the Dickinson substation, Dickinson, N. Dak., are shown in Figures 2 and 3, respectively.

TABLE 4.—*Annual and average yields of Kota and Marquis wheats grown in plats at 32 experiment stations during one or more of the five years from 1918 to 1922, inclusive.*

[Data from experiments conducted independently by the agricultural experiment station in the State named, unless otherwise indicated. The writers hereby acknowledge the courtesy of the various experiment station directors and agronomists in furnishing the data presented.]

Station and variety.	Acre yield (bushels).					Average.	
	1918	1919	1920	1921	1922	Acre yield for years grown.	Percentage of Marquis.
Fargo, N. Dak.:							
Kota.....	28.4	17.4	22.8	17.8	30.8	23.4	123.2
Marquis.....	21.5	15.7	12.2	19.4	26.1	19.0	100.0
Dickinson, N. Dak.: ¹							
Kota.....		6.6	22.4	4.2	31.0	16.1	114.2
Marquis.....		3.4	15.9	5.6	31.6	14.1	100.0
Mandan, N. Dak.: ²							
Kota.....			9.1	4.4	18.6	10.7	115.1
Marquis.....			7.4	3.8	16.7	9.3	100.0
Edgeley, N. Dak.:							
Kota.....			15.8	7.3	19.0	14.0	135.9
Marquis.....			9.2	7.7	14.0	10.3	100.0
Langdon, N. Dak.:							
Kota.....			14.5	14.2	32.2	20.3	123.0
Marquis.....			8.2	11.6	29.7	16.5	100.0
Williston, N. Dak.:							
Kota.....			7.0	19.0	30.0	18.7	94.4
Marquis.....			9.3	22.0	28.0	19.8	100.0
Hettinger, N. Dak.:							
Kota.....					33.7		105.3
Marquis.....					32.0		100.0
Newell, S. Dak. (irrigated): ³							
Kota.....					19.7		117.3
Marquis.....					16.8		100.0
Newell, S. Dak. (dry land): ³							
Kota.....					26.1		109.2
Marquis.....					23.9		100.0
Higmore, S. Dak.: ⁴							
Kota.....			4.7	6.2	21.7	10.9	125.3
Marquis.....			6.7	1.2	18.3	8.7	100.0
Eureka, S. Dak.: ⁴							
Kota.....				10.5	16.5	13.5	79.0
Marquis.....				10.8	23.3	17.1	100.0
Redfield, S. Dak.: ⁵							
Kota.....				1.8	21.4	11.6	71.2
Marquis.....				.9	31.6	16.3	100.0
Brookings, S. Dak.: ⁴							
Kota.....		5.9	3.3	13.3	14.2	9.2	153.3
Marquis.....		3.3	3.3	7.5	10.0	6.0	100.0
St. Paul, Minn.:							
Kota.....			17.9	23.0	27.8	22.9	91.2
Marquis.....			22.4	24.8	28.2	25.1	100.0
Crookston, Minn.:							
Kota.....			16.0	10.1	20.2	15.4	92.2
Marquis.....			17.5	15.1	17.4	16.7	100.0
Waseca, Minn.:							
Kota.....				13.6	28.3	21.0	112.9
Marquis.....				20.0	17.1	18.6	100.0

Footnotes at end of table.

TABLE 4.—Annual and average yields of Kota and Marquis wheats grown in plats at 32 experiment stations during one or more of the five years from 1918 to 1922, inclusive—Continued.

Station and variety.	Acre yield (bushels).						
	1918	1919	1920	1921	1922	Average.	
						Acre yield for years grown.	Percentage of Marquis.
Morris, Minn.:							
Kota.....				9.6	24.0	16.8	78.1
Marquis.....				12.5	30.4	21.5	100.0
Grand Rapids, Minn.:							
Kota.....				4.1	13.0	8.6	68.8
Marquis.....				6.5	18.4	12.5	100.0
Golden Valley, Minn.:							
Kota.....				1.6	11.6	6.6	100.0
Marquis.....				4.2	8.9	6.6	100.0
Duluth, Minn.:							
Kota.....				10.4	18.5	14.5	80.6
Marquis.....				16.7	19.2	18.0	100.0
Lincoln, Nebr.:							
Kota.....				6.8	9.6	8.2	74.5
Marquis.....				10.1	11.9	11.0	100.0
North Platte, Nebr.:							
Kota.....				4.2	8.5	6.4	45.4
Marquis.....				14.1	14.1	14.1	100.0
Ashland, Wis.:							
Kota.....				5.8	10.7	8.3	93.3
Marquis.....				7.1	10.6	8.9	100.0
Ames, Iowa: ¹							
Kota.....				5.0	6.0	5.5	52.4
Marquis.....				6.7	14.3	10.5	100.0
Hays, Kans.: ¹							
Kota.....				7.3	15.6	11.5	77.7
Marquis.....				12.8	16.7	14.8	100.0
Akron, Colo.: ⁶							
Kota.....			18.7	5.7	11.3	11.9	128.0
Marquis.....			14.4	7.4	6.0	9.3	100.0
Archer, Wyo.:							
Kota.....				11.3			78.5
Marquis.....				14.4			100.0
Sheridan, Wyo.: ²							
Kota.....				3.2	33.3	18.3	111.6
Marquis.....				1.9	30.9	16.4	100.0
Moccasin, Mont.: ¹							
Kota.....			21.0	28.3	26.5	25.3	96.6
Marquis.....			23.1	28.3	27.3	26.2	100.0
Havre, Mont.:							
Kota.....				15.2	3.5	9.4	106.8
Marquis.....				11.7	5.8	8.8	100.0
Bozeman, Mont.:							
Kota.....				40.7	57.0	48.9	98.4
Marquis.....				38.7	60.6	49.7	100.0
Nephi, Utah:							
Kota.....				17.7	9.2	13.5	104.7
Marquis.....				18.5	7.3	12.9	100.0
Moro, Oreg.: ¹							
Kota.....				17.0	10.3	13.7	74.5
Marquis.....				19.7	17.0	18.4	100.0
Lind, Wash.:							
Kota.....				8.5	4.7	6.6	101.5
Marquis.....				9.1	3.9	6.5	100.0

¹ Data from experiments conducted by the Office of Cereal Investigations of the Bureau of Plant Industry, in cooperation with the State agricultural experiment station.

² Data from experiments conducted cooperatively by the Offices of Cereal Investigations and Dry-Land Agriculture Investigations of the Bureau of Plant Industry.

³ Data from experiments conducted by the Offices of Western Irrigation Agriculture and Dry-Land Agriculture Investigations of the Bureau of Plant Industry.

⁴ Data reported in South Dakota Agricultural Experiment Station Bulletin No. 201.

⁵ Data from experiments conducted by the Office of Forage-Crop Investigations of the Bureau of Plant Industry.

⁶ Data from experiments conducted independently by the Office of Cereal Investigations of the Bureau of Plant Industry.

WHERE ADAPTED.

The yields recorded in Table 4 show that Kota wheat is well adapted to North Dakota. In the eastern portions of the State, where stem rust is usually severe, it has shown to the best advantage. At Fargo during the 5-year period from 1918 to 1922, inclusive, it has outyielded Marquis wheat by 4.4 bushels per acre, an increase over that variety of more than 23 per cent. Kota exceeded Marquis in yield in four out of the five years. In 1921, although stem rust was present, the yields were without doubt influenced to a greater degree by excessive heat than by rust.

At the Edgeley substation, in the southeastern part of North Dakota, Kota outyielded Marquis wheat by 3.7 bushels per acre, or an average increase of 35.9 per cent for the 3-year period from 1920 to 1922, inclusive. Significant differences were obtained in 1920 and 1922, but here, as at Fargo, the extreme heat in 1921 prematurely ripened both varieties and very slight differences in yield were



FIG. 3.—A field of Kota wheat in shock at the Dickinson substation, Dickinson, N. Dak., in 1922.

obtained, although Marquis showed 85 per cent of stem rust infection and Kota only 5 per cent.

At Langdon, in the northeastern part of the State, Kota has outyielded Marquis wheat in each of the three years from 1920 to 1922, inclusive, averaging 3.8 bushels per acre, or 23 per cent, higher.

In central and western North Dakota, where stem rust has been less severe, Kota wheat has not shown to so great advantage. At Mandan, however, it has outyielded Marquis in each of the three years from 1920 to 1922, inclusive, exceeding Marquis on the average by 1.4 bushels, or 15 per cent.

In the 4-year period from 1919 to 1922, inclusive, Kota has outyielded Marquis wheat at Dickinson, in the west-central part of the State, by 2 bushels per acre, or 14.2 per cent. In only one year, 1920, was stem rust a determining factor in wheat yields.

Yields of Kota and Marquis wheats are available for only one year, 1922, at the Hettinger substation, in southwestern North Dakota. In that year Kota yielded 33.7 bushels per acre, exceeding Marquis by 1.7 bushels, or 5.3 per cent.

The only station in North Dakota where Marquis has produced a higher average yield than Kota wheat is at Williston, in the north-western part of the State. In two of the three years from 1920 to 1922, Marquis outyielded Kota, the 3-year average being 1.1 bushels, or 5.4 per cent more. In none of the years was stem rust a factor, although it occurs in the Williston section.

Kota wheat is thus shown to be well adapted for growing in all parts of North Dakota. It has outyielded Marquis significantly in the eastern part of the State. Durum varieties are grown extensively there because they yield better than Marquis and other hard red spring wheats, due principally to their greater resistance to stem rust. The distribution of hard red spring and durum wheats in 1919 is shown in Figures 4 and 5.

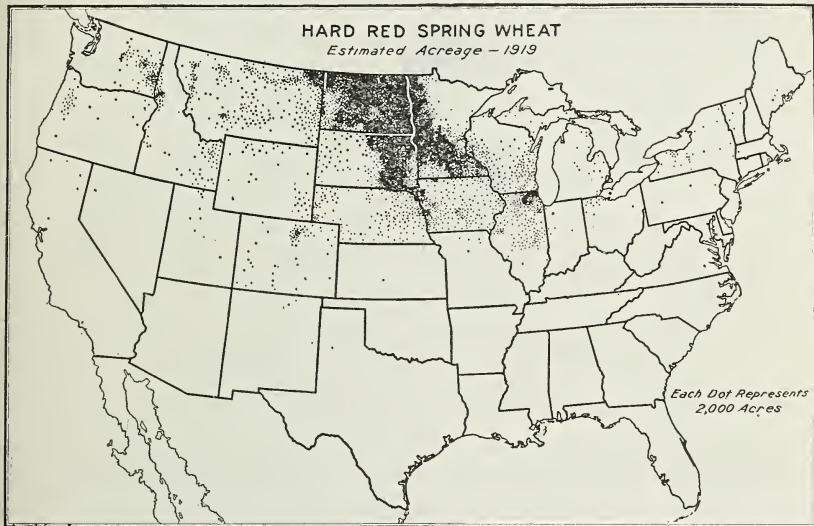


Fig. 4.—Outline map of the United States, showing where hard red spring wheat was grown in 1919. Estimated area, 16,326,800 acres.

Kota is about as resistant as the most rust-resistant durum varieties, D-5, Monad (D-1), and Acme, which have a lower value for the manufacture of semolina for macaroni, spaghetti, and similar products than other durum varieties. Kota is more resistant to stem rust than Kubanka and Arnautka, the most widely grown durum varieties, both of which make semolina of high quality. The durum acreage has increased entirely out of proportion to market demands for this class of wheat, with a consequent depressing effect on prices, durum wheat recently selling at a discount of from 20 to 40 cents a bushel below hard red spring.

Table 4 shows that in general Kota is adapted to the area where durum wheat is grown and is particularly well adapted to eastern North Dakota, the section of greatest production of durum wheat. Kota should be immediately useful in replacing durum wheat on the excess durum acreage. An additional acreage can be devoted to Kota as soon as seed is available by those who have unwillingly grown Marquis at the risk of stem-rust losses and who believe the growing of durum at recent prices to be unprofitable.

In South Dakota the situation is much like that in North Dakota. In the varietal experiments, however, Kota wheat has shown rather indifferent results in comparison with Marquis. At Brookings Kota has considerably exceeded Marquis in yield during the 4-year period from 1919 to 1922, inclusive, but at Eureka and Redfield Marquis has outyielded Kota in short-time experiments. At Highmore and Newell, in western South Dakota, Kota has significantly outyielded Marquis on dry land and also under irrigation at Newell.

In eastern Montana Kota appears to be as well adapted as Marquis. Experiments at Sheridan, Wyo., and Akron, Colo., show that in the eastern parts of those States Kota also may be well adapted.

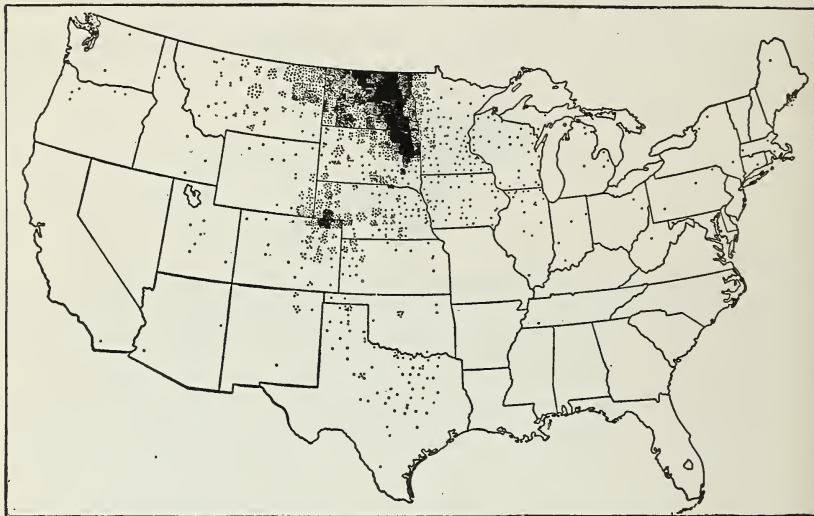


FIG. 5.—Outline map of the United States, showing where durum wheat was grown in 1919. Estimated area, 4,370,800 acres.

WHERE NOT ADAPTED.

In the more humid sections of the spring-wheat region, including Minnesota, Wisconsin, and Iowa, the Kota variety is not well adapted. Experiments in these States show that Kota lodges readily, and principally for this reason it yields poorly and is not suitable for humid conditions. This is shown in yields obtained from various stations in these States. In Nebraska and Kansas Kota also has not yielded as well as Marquis.

From central Montana westward Kota wheat has not proved to be well adapted. In experiments at Moccasin and Bozeman, Mont., and at Moro, Oreg., Kota in general has yielded less than Marquis, while at Nephi, Utah, and Lind, Wash., it has slightly exceeded Marquis. At each of these stations varieties of common white wheat have in the same years considerably outyielded both Marquis and Kota.

SUMMARY OF YIELDS.

To summarize briefly, the resistance of the Kota variety to stem rust and to drought makes it best adapted to the area where du-

rum wheat is most extensively grown. Kota is well adapted to all of North Dakota and has nearly always yielded well in comparison with Marquis in South Dakota and in the eastern parts of Montana, Wyoming, and Colorado.

MILLING AND BAKING VALUE.

The milling and baking value of a new variety of wheat is of much importance. Since 1918 samples of Kota wheat have been milled and baked in the experimental mill of the United States Department of Agriculture. Experiments also have been conducted in the experimental mill of the North Dakota Agricultural Experiment Station. In all, 63 samples of the variety have been milled and baked. Of these, 48 have been comparable with Marquis, as both varieties were grown under the same conditions. The samples milled by the United States Department of Agriculture were obtained from most of the agricultural experiment stations listed in Table 4, including those from the States which lead in the production of hard red spring wheat. Most of the samples were from the 1921 crop, only nine having been milled from grain grown during the three years from 1918 to 1920, inclusive. No tests of the 1922 crop are included. The data are summarized in the first section of Table 5. Loaves of bread baked from flour of Kota and Marquis wheats in these experiments are shown in Figure 6. The samples milled in the experiments of the North Dakota Agricultural Experiment Station were all obtained from North Dakota during the four years from 1919 to 1922, inclusive, six of the samples being of the 1922 crop. The data from these experiments are summarized in the second section of Table 5.

In these two series of experiments, independently conducted, Kota wheat had a heavier bushel weight and produced a larger percentage of flour and less feed than Marquis. In both experiments Kota also averaged higher than Marquis in crude protein in the flour, outstandingly higher in water absorption, and slightly higher in weight of loaf. In the experiments of the United States Department of Agriculture, Kota further exceeded Marquis in texture of loaf, but averaged lower in volume and color of the loaf. The experiments also showed Kota to have a higher ash content than Marquis. This apparently is characteristic of the Kota variety, although in part it may be due to the higher flour extraction. A larger quantity of nutritive ash in itself is not objectionable, although bakers rely more or less on the ash content as a measure of flour extraction and sometimes object to flour of high ash content.

In the North Dakota experiments Kota wheat had a larger average loaf volume than Marquis and scored higher in color of loaf but not in texture. The ash content was not determined. No one character is uniformly unfavorable in both series of experiments. The lack of accord in the result from the two experimental mills is due largely to the different sources of the samples and the different years in which the wheat was grown. The 1921 samples of Kota showed comparatively less favorable results than those grown in other years.

TABLE 5.—*Summary of milling and baking data from 63 samples of Kota wheat and from 48 of these Kota samples and 48 comparable samples of Marquis grown in the 5-year period from 1918 to 1922, inclusive.*

Descriptive data.	All Kota samples.	Comparable samples.		
		Kota.	Marquis.	Percentage of Marquis.
Data from the United States Department of Agriculture: ¹				
Number of samples.....	38	33	33	-----
Bushel weight, mill cleaned..... pounds.	60.7	60.4	57.8	104.5
Crude protein content of wheat (N×5.7, basis 13.5 per cent moisture)..... per cent.	15.4	15.6	15.0	104.0
Yield of straight flour..... do.	72.2	71.9	70.1	102.6
Yield of shorts..... do.	15.3	15.2	14.5	104.8
Yield of bran..... do.	14.2	14.4	17.0	84.7
Water absorption of flour..... do.	64.2	64.4	60.2	107.0
Volume of loaf..... cubic centimeters.	2,257	2,263	2,380	95.1
Weight of loaf..... grams.	506	506	497	101.8
Texture of loaf..... score.	90.8	90.8	89.4	101.6
Color of loaf..... do.	88.7	88.6	90.8	97.6
Ash in straight flour..... per cent.	0.58	0.60	0.53	113.2
Data from the North Dakota Agricultural Experiment Station: ²				
Number of samples.....	25	15	15	-----
Bushel weight, dockage free..... pounds.	59.0	59.1	55.2	107.1
Crude protein content of wheat..... per cent.	³ 13.3	⁴ 13.6	⁴ 13.1	103.8
Yield of straight flour..... do.	75.3	75.2	71.6	105.0
Yield of feed..... do.	24.7	24.9	28.4	87.7
Water absorption of flour..... do.	59.5	59.4	56.8	104.6
Weight of loaf..... grams.	-----	477	469	101.7
Volume of loaf..... cubic centimeters.	2,443	2,393	2,298	104.1
Texture of loaf..... score.	91.8	92.2	92.9	99.2
Color score of loaf..... do.	89.8	90.9	88.8	102.4

¹ Experiments conducted by the Milling Investigations Section of the Grain Division of the Bureau of Agricultural Economics in cooperation with the Office of Cereal Investigations of the Bureau of Plant Industry.

² Experiments conducted by the Experimental Mill, Chemistry Department, in cooperation with the Agronomy Department.

³ Average of only 20 samples.

⁴ Average of only 11 samples.

The shade of color of the loaf is not indicated in the tables. The Kota loaf is usually creamier, containing more carotin, or yellow pigment, than the Marquis loaf. This character of Kota is similar to that of the hard red winter wheats. Flour commonly is bleached to meet the popular demand for a white loaf of bread. In a few States the sale of bleached flour is unlawful. In these States the yellowish tinge in the Kota loaf may be objectionable.

In these experiments Kota compares favorably with Marquis wheat. Kota is distinctly superior to Marquis in the important characters of bushel weight, yield of flour, crude protein content, and water absorption. Kota is fully equal to Marquis in the other characters except in ash in the flour and in color of loaf.

KEEP KOTA SEED PURE.

The prices of both commercial and seed wheat have suffered severely because of mixtures of classes and varieties. Losses to farmers resulting from mixtures of hard red spring and amber durum wheats have been enormous. It also is a difficult matter to obtain pure seed wheat of high quality. Kota wheat stocks at present are believed to be of greater purity than the present stocks of most varieties now grown. Kota growers of the future are urged to maintain this original purity, not only for their own economic betterment but for the general welfare of the wheat industry.

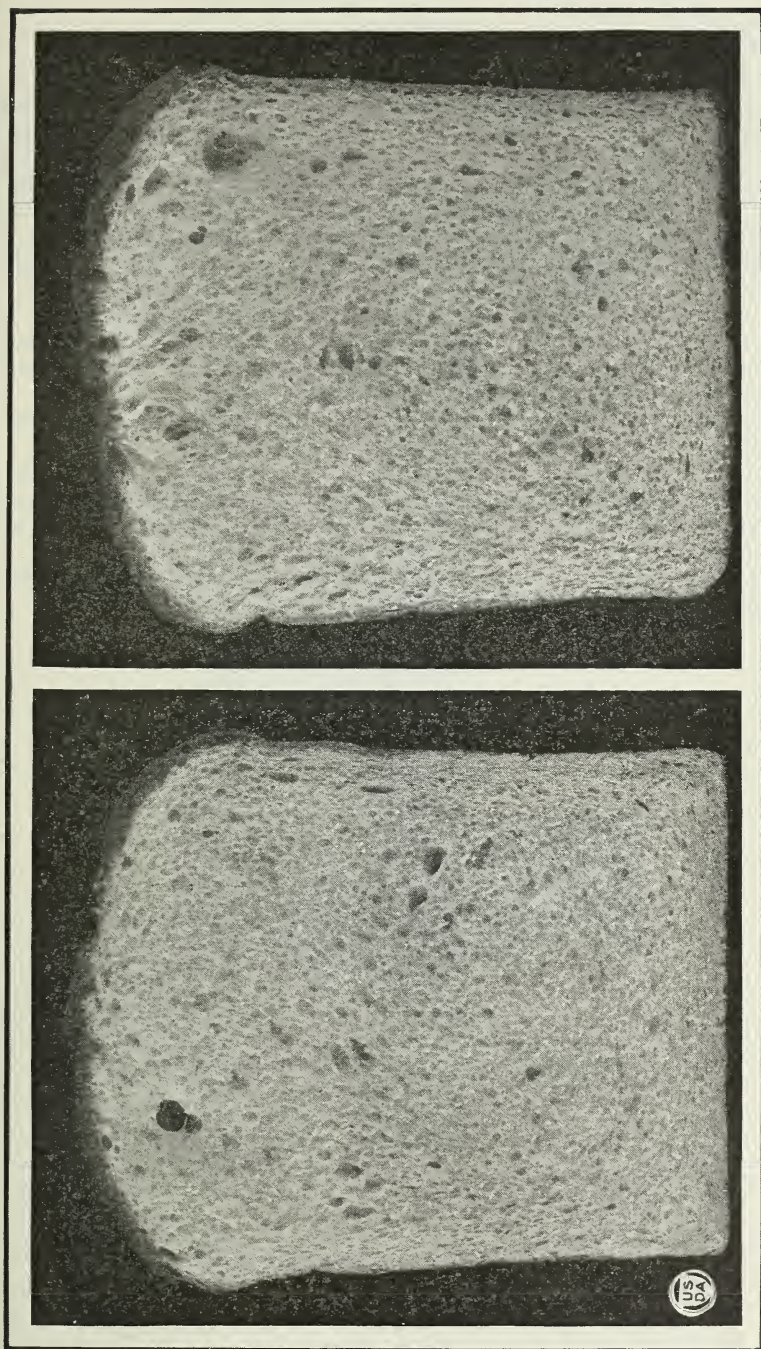


FIG. 6.—Loaves of bread made from Kota (left) and Marquis (right) wheats, grown at Fargo, N. Dak., in 1922. The volume of each loaf was 2,210 cubic centimeters.

SUMMARY.

Kota is a variety of wheat of the hard red spring class. It was introduced from Russia and developed concurrently by the United States Department of Agriculture and the North Dakota Agricultural Experiment Station.

Kota is resistant to the principal forms of black stem rust which occur in the hard red spring wheat region. It is a bearded wheat which ripens about as early as Marquis. It is fairly resistant to drought and outyields Marquis in North Dakota, having averaged nearly 3 bushels more during the past three to five years.

In milling and baking experiments conducted independently by the United States Department of Agriculture and the North Dakota Agricultural Experiment Station, Kota wheat has shown results nearly equal to those obtained with Marquis.

It is estimated that about 6,000 acres of Kota wheat were grown in 1922.

Kota is best adapted to the district where durum wheat is extensively grown and could replace much of the durum wheat now grown in eastern North Dakota and South Dakota with profit to both the hard red spring and the durum wheat industries.

This new variety is recommended for North Dakota and adjacent portions of neighboring States.

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